PB91-161414

Ambient Water Quality Criteria Document Addendum for Nitrophenols

(U.S.) Environmental Protection Agency, Cincinnati, OH

Dec 89

U.S. Department of Commerce
National Technical Information Service
NTIS

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1 PB91-161414	2. REPORT DATE September, 1988	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
Ambient Water Quality Criteria Document Addendum for Nitrophenols.

5. FUNDING NUMBERS

6. AUTHOR(S)
Criteria Branch/Office of Water Regulations & Standards

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. EPA/Office of Water Regulations & Standards
Criteria Branch (WH-585)
401 M Street SW
Washington, D.C. 20460

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Addendum to PB 81-117749

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Under the 1977 Clean Water Act, Congress mandated the U.S. Environmental Protection Agency to develop ambient water quality criteria for 129 priority Pollutants. These criteria were published in 1980. Under Section 304(a)(1) of the Clean Water Act as amended in 1987, the U.S. EPA is mandated to re-evaluate and update these criteria every five jears. These addenda represent an updated literature search current as of 1988, plus additional information form Agency files and Program Offices. This addendum is to update the existing Ambient Water Quality Criteria Document for Nitrophenols.

14. SUBJECT TERMS

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
unclassified	unclassified	unclassified	unlimited release

PB91-161414

United States
Environmental Protection
Agency

FINAL DRAFT
ECAO-CIN-661
December, 1989

EPA

Research and Development

AMBIENT WATER QUALITY CRITERIA DOCUMENT ADDENDUM FOR NITROPHENOLS

Prepared for

OFFICE OF WATER REGULATIONS
AND STANDARDS

Prepared by

Environmental Criteria and Assessment Office
Office of Health and Environmental Assessment
U.S. Environmental Protection Agency
Cincinnati, OH 45268

DRAFT: DO NOT CITE OR QUOTE

NOTICE

This document is a preliminary draft. It has not been formally released by the U.S. Environmental Protection Agency and should not at this stage be construed to represent Agency policy. It is being circulated for comments on its technical accuracy and policy implications.

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

DISCLAIMER

This report is an external draft for review purposes only and does not constitute Agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

Under the 1977 Clean Water Act, Congress mandated the U.S. Environmental Protection Agency to develop ambient water quality criteria for 129 priority pollutants. These criteria were published in 1980. Under Section 304(a)(1) of the Clean Water Act as amended in 1987, the U.S. EPA is mandated to re-evaluate and update these criteria every five years. These addenda represent an updated literature search current as of 1988, plus additional information from Agency files and Program Offices. The first draft of this addendum was prepared by Syracuse Research Corporation under contract no. 68-C8-0004.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
REVIEW OF NEW DATA	4
Toxicologic/Carcinogenic Effects	4
Bioconcentration Factor (BCF)	6
QUANTIFICATION OF EFFECTS	7
Mononitrophenols	7
Dinitrophenols	7
Trinitrophenols	8
Dinitrocresols	9
EXISTING STANDARDS AND CRITERIA	12
Mononitrophenols	12
Dinitrophenols	12
Trinitrophenols	12
Dinitrocresols	12
REFERENCES	14

INTRODUCTION

Under Section 304(a)(1) of the Clean Water Act of 1977 as amended in 1987, the U.S. EPA is required to publish criteria for water quality accurately reflecting the latest scientific knowledge regarding the effects on health and welfare that may occur from the presence of pollutants in any body of water, including groundwater. In accordance with the 1977 act, Ambient Water Quality Criteria Documents (AWQCDs) were developed in 1980 for 65 toxic pollutants or classes of pollutants listed under Section 307(a)(1).

These addenda are intended to serve as an update of the original AWQCDs. The addenda provide the Agency with the latest scientific assessments of potential health hazards associated with these pollutants and serve as guidelines for modifying the current (1980) AWQCDs.

The human health criteria in these addenda are based on Agency verified risk assessment values when available. These values consist of reference doses (RfD) for those chemicals believed to be systemic toxicants (i.e., do not induce cancer) and cancer risk factors for those thought likely to cause cancer in humans. The verification process consists of a review and consensus of risk assessment values provided by an Agency workgroup consisting of scientists from each of the major Agency offices. Assessments for noncarcinogens are verified by the RfD workgroup and those for carcinogens are verified by the Carcinogen Risk Assessment Verification Endeavor (CRAVE) workgroup. If such values are not available, the criteria are based on the most recent Agency health assessment. In the absence of any appropriate Agency value, RfD values or cancer risk factors are derived by current Agency methods if adequate new data are available, and criteria are recommended based on the proposed RfD or risk factor.

LIST OF ABBREVIATIONS

BCF	Bioconcentration factor
CRAVE	Carcinogen Risk Assessment Verification Endeavor
LOAEL	Lowest-observed-adverse-effect level
NOAEL	No-observed-adverse-effect level
PEL	Permissible exposure limit
ppm	Parts per million
RfD	Reference dose
RQ	Reportable quantity
STEL	Short-term exposure level
TLV	Threshold limit value
TWA	Time-weighted average

The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfD is derived by dividing a NOAEL or LOAEL for subchronic or chronic exposure by standard uncertainty factor(s) times an additional uncertainty factor:

$$RfD = \frac{\text{NOAEL or LOAEL}}{UF(s) \times UF}$$

The standard uncertainty factors are applied to reflect the various types of data used to estimate RfDs. An uncertainty factor of 10 is used to account for variations in human sensitivity when extrapolating from valid human studies involving long-term exposure of average, healthy subjects. An additional 10-fold factor is used for each of the following: to extrapolate from long-term animal studies to the case of humans, to extrapolate from subchronic animal studies to chronic exposure, and to extrapolate from a LOAEL to a NOAEL. An additional uncertainty factor of >0-10 may be applied to reflect professional assessment of the uncertainties of the study and data base not explicitly addressed by the standard uncertainty factors (i.e., completeness of the overall data base). The default value for the additional uncertainty factor is 1.

In assessing the carcinogenic potential of a chemical, the U.S. EPA classifies the chemical into one of the following groups according to the degree of evidence in epidemiological studies and animal studies: Group A - Human Carcinogen; Group B - Probable Human Carcinogen [limited evidence in humans with or without sufficient evidence in animals (Group B1) or inadequate evidence in humans with sufficient evidence in animals (Group B2)]; Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals in the absence of human data); Group D - Not Classifiable as to

Human Carcinogenicity (inadequate or no evidence); Group E - Evidence of Noncarcinogenicity for Humans. Quantitative carcinogenic risk assessments are performed for chemicals in Groups A and B, and on a case-by-case basis for chemicals in Group C. Upper-bound cancer unit risks (slope values) are estimated through the use of mathematical extrapolation models. Most commonly for animal data, the linearized multistage model with a 95% upper confidence limit is used to provide a low-dose estimate of cancer risk. The cancer risk is characterized as an upper-limit estimate (i.e., the true risk to humans, while not identifiable, is not likely to exceed the upper-limit estimate and in fact may be lower). Alternative risk models to the multi-stage model, such as the one-hit, Weibull, Logit or Probit model, are available and may be used when the evidence indicates that they may be more appropriate. In the absence of such evidence, the Agency recommends the linearized multistage model to provide consistency of approach and an upper-bound on the potential carcinogenic risk. In the case where human data are used for quantitative risk assessment, an upper-bound estimate rather than a 95% upper-bound estimate is used when low-dose linearity is assumed.

In the development of this Addendum to the AWQCD on nitrophenols, recent Agency assessments have been consulted. A computerized literature search was conducted to cover studies published more recently than the latest Agency assessment (i.e., published in 1985 to 1988 for the nitrophenols and in 1986 to 1988 for the dinitrocresols). New key studies have been evaluated.

REVIEW OF NEW DATA

Toxicologic/Carcinogenic Effects

Mononitrophenols

Ambient water quality criteria were not derived for mononitrophenols by U.S. EPA (1980) because data were inadequate. New pertinent data for these compounds are sparse.

In a preliminary developmental toxicity test of p-nitrophenol, 50 pregnant CD-1 mice/group were administered 0 or 400 mg/kg (believed to be at or just below the adult lethality threshold) by gavage for 8 consecutive days beginning on gestation day 7 (Plasterer et al., 1985). Maternal toxicity and reproductive and developmental endpoints were monitored. Significantly increased maternal mortality and reduced weight gain were reported. The only evidence of fetotoxicity was a slight but not significant reduction in the number of live pups/litter on postpartum days 1 and 3.

A carcinogenicity test of p-nitrophenol has been initiated. Manus (1988) is currently testing groups of male Swiss mice for carcinogenic effects from dermal exposure to p-nitrophenol for 103 weeks. Based on a lack of data, U.S. EPA (1985a, 1987) assigned the mononitrophenols to Group D, not classifiable as to human carcinogenicity.

Dinitrophenols

The U.S. EPA (1980) based ambient water quality criteria for the dinitrophenols on the cataractogenic properties of 2,4-dinitrophenol in humans (see Dinitrophenols in next section). New pertinent data regarding the toxicity or carcinogenicity of the dinitrophenols were not located in the available literature.

Trinitrophenols

Data were inadequate for U.S. EPA (1980) to derive ambient water quality criteria for the trinitrophenols. Pertinent data for these compounds are limited to a carcinogenicity study by van Esch et al. (1957), which had not been reviewed by the U.S. EPA (1980). These researchers administered 500 ppm 2,4,6-trinitrophenol in the diet to both sexes of Wistar rats (number not reported) for 2.5 years. Two control groups were used: a group of 19 untreated rats from this experiment and a group of 83 untreated rats from a series of other toxicity tests conducted in this laboratory. No significant differences between control and treated rats in incidence or type of tumor were noted. The evidence was considered inconclusive, however, because of an abnormally high incidence of mammary tumors (42%) in control rats. Therefore, trinitrophenols are most appropriately classified as Group D chemicals according to U.S. EPA (1986b).

Dinitrocresols

Because of insufficient data, ambient water quality criteria were not calculated for dinitrocresols other than 4,6-dinitro-o-cresol (U.S. EPA, 1980). Criteria for dinitrocresols were based on the NIOSH (1978) criterion of 0.2 mg/m³ in air. Pertinent new data are limited to a subchronic dietary study in rats. In a 90-day study, Den Tonkelaar et al. (1983) exposed 20 Wistar rats/sex/group to 4,6-dinitro-o-cresol at dietary levels of 0, 50, 100, 200 or 400 ppm. Mortality, food consumption, body weight, clinical chemistry and histopathology were evaluated. At the lowest concentration (50 ppm) ketones appeared in the urine, and decreased pyruvate, T_3 and T_4 levels were found in the blood. At 100 ppm, reduced growth and feed efficiency and altered urinalysis were reported. Increased mortality occurred at $\geq$200 ppm.

According to the IARC classification scheme, dinitrocresol is a Group 3 chemical - not classifiable as to their carcinogenicity in humans, and U.S. EPA Group D - not classifiable as to human carcinogenicity (U.S. EPA, 1986a). Although the designation of the dinitrocresols in U.S. EPA (1986a) appears as a U.S. EPA Group E substance, this is a typographical error; there are no cancer data and U.S. EPA Group D is the most appropriate classification.

Bioconcentration Factor (BCF)

Pertinent new information concerning the bioconcentration factor for nitrophenols is currently undergoing Agency review. The BCF values of 1.51 for 2,4-dinitrophenol and 5.49 for 4,6-dinitro-o-cresol determined in U.S. EPA (1980) will be used until this review is final.

QUANTIFICATION OF EFFECTS

Mononitrophenols

Ambient water quality criteria could not be derived by U.S. EPA (1980) for class mononitrophenols or any of its isomers because data were insufficient. U.S. EPA (1980) reported organoleptic detection thresholds for nitrophenols ranging from 0.24-389 mg/ℓ, based upon Russian literature. Data from which to derive criteria for any of the mononitrophenols continues to be inadequate.

Dinitrophenols

Insufficient data were available to the U.S. EPA (1980) for calculating ambient water quality criteria for dinitrophenols other than 2,4-dinitrophenol. The U.S. EPA (1980) derived an ambient water quality criterion for 2,4-dinitrophenol from the human exposure data of Horner (1942), who analyzed >100 anecdotal cases of human consumption of 2,4-dinitrophenol as a slimming agent. This practice resulted in cataract formation from dosages as low as 2 mg/kg/day. Other toxic effects from such usage included gastrointestinal disturbances (nausea, vomiting, colic, diarrhea, anorexia), weakness, dizziness, headache, profuse sweating and loss of weight. Several fatalities were attributed to 2,4-dinitrophenol exposure. Using the LOAEL of 2 mg/kg/day and applying an uncertainty factor of 1000 (10 for estimation of a NOAEL from a LOAEL, 10 for demonstrated bacterial mutagenicity and 10 for suspected ability of 2,4-dinitrophenol to induce chromosomal breaks in mammals), and applying the additional assumptions that a 70 kg human consumes 2 ℓ of water and 6.5 g of fish and shellfish/day with a BCF of 1.51, the criterion of 70 µg/ℓ was derived. For consumption limited to fish and shellfish alone, the criterion was 14.3 mg/ℓ (U.S. EPA, 1980).

The verified oral RfD (U.S. EPA, 1989) of 0.002 mg/kg/day for 2,4-dinitrophenol can serve as the basis for the ambient water quality criteria. It is based on the same data from Horner (1942) that was used by U.S. EPA (1980) in deriving the existing criteria. Although the criteria themselves would not be altered, current RfD derivation methods differ from those applied by U.S. EPA (1980). In verifying the oral RfD, the U.S. EPA (1989) applied an uncertainty factor of 1000 to the Horner (1942) LOAEL of 2 mg/kg/day, but based it on different sources of uncertainty than those chosen by U.S. EPA (1980). The U.S. EPA (1989) derived the verified value by applying an uncertainty factor of 10 for extrapolation from subchronic exposure to chronic exposure, 10 for intraspecies variation in sensitivity and 10 for extrapolation from a LOAEL to a NOAEL. Assuming that a 70 kg person consumes 2 ℓ of water and 6.5 g of fish and shellfish daily, and a BCF of 1.51, the criterion of 70 µg/ℓ is once again derived. If consumption is limited to fish and shellfish alone, the criterion is 14.3 mg/ℓ. Therefore, no change in criteria levels is recommended for 2,4-dinitrophenol.

Data continue to be inadequate for derivation of criteria for any of the other dinitrophenols, and the criteria for the 2,4-isomer may be applied to the other dinitrophenols as suggested by U.S. EPA (1980).

Trinitrophenols

The U.S. EPA (1980) determined that data were insufficient to derive ambient water quality criteria for any of the trichlorophenol isomers. The only reported health effects from exposure to these compounds was an outbreak of hematuria among U.S.Navy personnel exposed to 2,4,6-trinitrophenol in drinking water on shipboard. It was not possible to estimate the concentration of the chemical or the duration of exposure.

Pertinent new data that could serve as the basis for criteria formulation for trinitrophenols have not been located in the literature.

Dinitrocresols

The U.S. EPA (1980) determined that available data were insufficient to derive criteria for dinitrocresols, with the exception of 4,6-dinitro-o-cresol. The suggested criteria for 4,6-dinitro-o-cresol were 13.4 µg/ℓ for consumption of contaminated water, fish and shellfish, and 765 µg/ℓ for consumption of contaminated fish and shellfish alone. These values were based on the NIOSH (1978) criterion of 0.2 mg/m³ in workroom air. Assumptions applied in deriving the water quality criteria were: an average respiratory rate of 28.6 ℓ of air/minute; exposure for 8 hours/day, 7 days/week; comparable absorption rates from the respiratory and gastrointestinal tract; 70 kg body weight (estimated daily dosage = 39 µg/kg/day); daily consumption of 2 ℓ water and 6.5 g fish and shellfish; a BCF of 5.49; an uncertainty factor of 100 (10 for extrapolation to chronic exposure and 10 for intraspecies variations in sensitivity).

U.S. EPA (1986a) reevaluated the available toxicity data on 4,6-dinitro-o-cresol. Although several subchronic dietary animal studies were available, they were considered inappropriate for the derivation of criterion because the potential for chronic toxicity appears to be much greater in humans than animals and the critical effect in humans following oral exposure appears to be conjunctivitis and cataract formation, which has not been reported in animals.

Although not chronic, human oral exposure information is available. A LOAEL of 0.35 mg/kg/day resulting in elevated basal metabolism rate, excessive sweating, fatigue and discoloration of the conjunctiva was observed in humans ingesting 4,6-dinitro-o-cresol for 9 weeks. Doses of $\geq$1.0 mg/kg/day

produced more severe toxic effects including cataracts and blindness (Plotz, 1936). Using the LOAEL of 0.35 mg/kg and applying an uncertainty factor of 1000 (10 for intrahuman variability, 10 for use of a LOAEL, and 10 for exposure duration of 9 weeks), an RfD of 0.35×10^{-3} mg/kg/day can be derived. The resulting ambient water criteria would be 12 µg/ℓ for consumption of contaminated water, fish and shellfish and 687 µg/ℓ for consumption of fish and shellfish alone. U.S. EPA (1986a) recommended an interim RfD of 0.0001 mg/kg/day based on the TLV of 0.2 mg/m³ [the NIOSH (1978) criterion used by U.S. EPA (1980)], and using current methodology the following assumptions were applied: a human respiratory rate of 10 m³/8-hour day, occupational exposure on 5 days/week, a ratio of respiratory to gastrointestinal absorption of 0.5, and an uncertainty factor of 100. U.S. EPA (1986a) considered that since the data base was limited, this value is supported by the human oral data and since there appears to be a greater than usual variability in the sensitivity of humans a more conservative approach was recommended.

Using this recommended interim RfD of 0.0001 mg/kg/day, ambient water criteria of 3.4 µg/ℓ for the consumption of contaminated water, fish and shellfish and 196 µg/ℓ for fish and shellfish alone can be derived.

Although the use of the TLV (0.2 mg/m³) corrected for gastrointestinal absorption would result in the most conservative estimate of ambient water criteria, according to current U.S. EPA (1989) guidelines, the use of a TLV in deriving an oral RfD is not recommended because of the uncertainties encountered in route extrapolation when accurate pharmacokinetic data are not available. The data base for 4,6-dinitro-o-cresol is currently undergoing Agency review and will be reevaluated based on structure-activity and pharmacokinetic parameters. Until this review has been completed, interim

ambient water criteria of 12 µg/ℓ for consumption of water, fish and shellfish and 687 µg/ℓ for fish and shellfish based on the oral human data is recommended. Inadequate data on the remaining dinitrocresols preclude derivation of ambient water quality criteria for them.

EXISTING STANDARDS AND CRITERIA

Mononitrophenols

The USSR established drinking water limits of 0.06 mg/ℓ for 2- and 3-nitrophenol, and 0.02 mg/ℓ for 4-nitrophenol (Stofen, 1973).

CFR (1982) reported tolerances for the herbicide, fluorodifen, and its metabolites (including 4-nitrophenol). For peanut hulls, peanuts and peanut vine hay the tolerance is 0.2 ppm. For soybean forage, soybeans, and seed and pod vegetables and their forages, the tolerance is 0.1 ppm.

Dinitrophenols

The USSR established a drinking water limit of 0.03 mg/ℓ for 2,4-dinitrophenol (Stofen, 1973).

A verified oral RfD of 0.002 mg/kg/day for 2,4-dinitrophenol was established on February 5, 1986, by the U.S. EPA (1989) based on human chronic and subchronic data from a study by Horner (1942), in which >100 anecdotal cases of cataracts resulting from therapeutic use of 2,4-dinitrophenol were analyzed (see Dinitrophenols in previous section).

The RQ for 2,4-dinitrophenol is 10 pounds, based upon aquatic toxicity data (U.S. EPA, 1989).

Trinitrophenols

ACGIH (1987) has established a TLV-TWA of 0.1 mg/m³ and a STEL of 0.3 mg/m³ for 2,4,6-trinitrophenol (picric acid), designed to protect against systemic toxicity and dermal effects (ACGIH, 1986). The OSHA (1985) PEL is also 0.1 mg/m³.

Dinitrocresols

Guidelines or standards for dinitrocresols are limited to those for 4,6-dinitro-o-cresol. The National Academy of Science Drinking Water Limit for this compound is 1 µg/ℓ (U.S. EPA, 1985b).

OSHA (1985) has determined that the PEL for 4,6-dinito-o-cresol is 0.2 mg/m³, in agreement with the NIOSH (1978) criterion and the ACGIH (1987) TLV-TWA, designed to protect against debilitating symptoms (ACGIH, 1986). The dermal route of exposure is believed to contribute substantially to the overall exposure of 4,6-dinitro-o-cresol (ACGIH, 1986).

REFERENCES

ACGIH (American Conference of Governmental Industrial Hygienists). 1986. Documentation of the Threshold Limit Values and Biological Exposure Indices, 5th ed. Cincinnati, OH. p. 215, 490.

ACGIH (American Conference of Governmental Industrial Hygienists). 1987. Threshold LImit Values and Biological Exposure Indices for 1987-1988. Cincinnati, OH. p. 20, 30.

CFR (Code of Federal Regulations). 1982. Fluorodifen: Tolerances for Residues. 40 CFR 180.290. (Cited in U.S. EPA, 1987)

Den Tonkelaar, D.E.M., F.X.R. Van Leeuwen and C. Kuiper. 1983. Semichronic toxicity testing of DNOC in the rat. Meded. Fac. Landbouwwet., Rijksuniv. Gent. 48(4): 1015-1022. (Cited in U.S. EPA, 1986a)

Horner, W.D. 1942. Dinitrophenol and its relation to formation of cataract. Arch. Ophthalmol. 27: 1097-1121.

Manus, A.G. 1988. Toxicity and carcinogenicity tests of p-nitrophenol (mice). Crisp Data Base, National Institute of Health, Rockville, MD. (Taken from CRISP/88/ES45040-09)

NIOSH (National Institute for Occupational Safety and Health). 1978. Criteria for a Recommended Standard: Occupational Exposure to Dinitro-ortho-creosol. U.S. Dept. Health, Education, Welfare, Washington, DC. (Cited in U.S. EPA, 1980)

OSHA (Occupational Safety and Health Administration). 1985. Occupational Standards and Permissible Exposure Limits. 29 CFR 1910.1000.

Plasterer, M.R., W.S. Bradshaw, G.M. Booth, M.W. Carter, R.L. Schuler and B.D. Hardin. 1985. Developmental toxicity of nine selected compounds following prenatal exposure in the mouse: Naphthalene, p-nitrophenol, sodium selenite, dimethyl phthalate, ethylenethiourea, and four glycol ether derivatives. J. Toxicol. Environ. Health. 15(1): 25-38.

Plotz, M. 1936. Dinitro-ortho-creosol: A metabolic stimulator and its toxic side-actions. NY State J. Med. 36: 266.

Stofen, D. 1973. The maximum permissible concentration in the U.S.S.R. for harmful substances in drinking water. Toxicology. 1: 187-195. (Cited in U.S. EPA, 1980)

U.S. EPA. 1980. Ambient Water Quality Criteria Document for Nitrophenols. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Water Regulations and Standards, Washington, DC. EPA 440/5-80-063. NTIS PB81-117749.

U.S. EPA. 1984. Health and Environmental Effects Profile for Trinitrophenols. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste, Washington, DC. EPA?600/X-84/141. NTIS PB88-131081/AS.

U.S. EPA. 1985a. Health and Environmental Effects Profile for Nitrophenols. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste and Emergency Response, Washington, DC. EPA/600/X-85/354. NTIS PB88-180450/AS.

U.S. EPA. 1985b. OHM-TADS (Oil and Hazardous Materials Technical Assistance Data System). Online: October, 1985. (Cited in U.S. EPA, 1986a)

U.S. EPA. 1986a. Health and Environmental Effects Profile for Dinitrocresols. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste and Emergency Response, Washington, DC. EPA/600/X-86/197. NTIS PB88-220769/AS.

U.S. EPA. 1986b. Guidelines for Carcinogen Risk Assessment. Federal Register. 51(185): 33992-34003.

U.S. EPA. 1987. Health Effects Assessment for Nitrophenols. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Emergency and Remedial Response, Washington, DC. EPA/600/8-88/050. NTIS PB88-178967.

U.S. EPA. 1989. Integrated Risk Information System (IRIS). Online. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

van Esch, G.J., H.H. Vink and H. van Genderen. 1957. Influence of hexanitrodiphenylamine on the incidence of neoplasms in the mammary tissue of rats. Nature. 180(4584): 509-510. (Cited in U.S. EPA, 1984)